UNIVERSITI SAINS MALAYSIA

First Semester Examination
2014/2015 Academic Session

December 2014 / January 2015

EBS 209/3 – Mineralogy
[Mineralogi]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains TEN printed pages before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper consists of SEVEN questions. TWO question in PART A and FIVE questions in PART B.
[Kertas soalan ini mengandungi TUJUH soalan. DUA soalan di BAHAGIAN A dan LIMA soalan di BAHAGIAN B.]

Instruction: Answer **FIVE** questions. Answer **ALL** questions from PART A and **THREE** questions from PART B. If a candidate answers more than five questions only the first five questions answered in the answer script would be examined.
*[**Arahan**: Jawab **LIMA** soalan. Jawab **SEMUA** soalan dari BAHAGIAN A dan **TIGA** soalan dari BAHAGIAN B. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

The answers to all questions must start on a new page.
[Mulakan jawapan anda untuk semua soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

In the event of any discrepancies in the examination questions, the English version shall be used.
[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

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PART A / *BAHAGIAN A*

1. [a] Calculate the molecular weight (%) of the mineral chalcopyrite ($CuFeS_2$) and olivine (Mg_2SiO_4) as well as their respective mineral group and class. Also state the name of the cation oxides given below.

Kirakan berat molekul (%) mineral kalkopirit ($CuFeS_2$) dan olivin (Mg_2SiO_4), termasuk kumpulan mineral dan kelas masing-masing. Nyatakan juga nama-nama oksida kation atau kelas mineral yang diberikan di bawah.

(i) CaO (iv) Na_2O

(ii) TiO_2 (v) $(PO_4)^{-3}$

(iii) Al_2O_3 (vi) S^{-2}

(30 marks/*markah*)

[b] Minerals have distinguishing physical properties, that in most cases can be used for identification (identifying tool). State and describe four (4) such common physical properties. Based on the selected typical physical properties, how can the following minerals be distinguished:

(i) Quartz (ii) Galena (iii) Calcite

Mineral mempunyai sifat-sifat fizikal unik yang dapat membantu dalam pengecaman identitinya (alat pengecaman). Nyatakan dan terangkan empat (4) sifat-sifat fizikal lazim berkenaan. Berdasarkan sifat-sifat fizikal lazim terpilih, bagaimanakah mineral-mineral berikut boleh dikenalpasti:

(i) Kuarza (ii) Galena (iii) Kalsit

(30 marks/*markah*)

[c] Define density and specific gravity (S.G.). Explain the main factors that govern specific gravity of minerals?

If a common sulfide mineral, pyrite (FeS_2) has a density of 5.02 g/cm^3 and unit cell edge of 5.42Å, calculate Z, that is the number of formula units per cell.

Takrifkan ketumpatan dan graviti tentu (S.G.). Terangkan faktor utama yang mengawal ketumpatan tentu sesuatu mineral itu?

Sekiranya mineral sulfida yang lazim iaitu pirit (FeS_2) mempunyai ketumpatan 5.02 g/cm^3 dan sistem sel unit 5.42Å, kirakan nilai Z, iaitu bilangan unit-unit formula per unit sel.

(40 marks/*markah*)

2. [a] (i) For the given elements below, state those elements which belong to the native element group of minerals?

Cs, Ba, As, Re, Au, C, B, F, Na, Sb, Fe, S, Cu and Ag

Bagi elemen-elemen yang tersenarai di bawah, nyatakan unsur-unsur yang manakah tergolong dalam kumpulan unsur jati?

Cs, Ba, As, Re, Au, C, B, F, Na, Sb, Fe, S, Cu dan Ag

(ii) Calculate the empirical formula for the following copper-bearing mineral which has the following weight % composition.

Cu^{+2} = 63.3% S^{-2} = 25.5%, Fe^{+3} = 11.2%

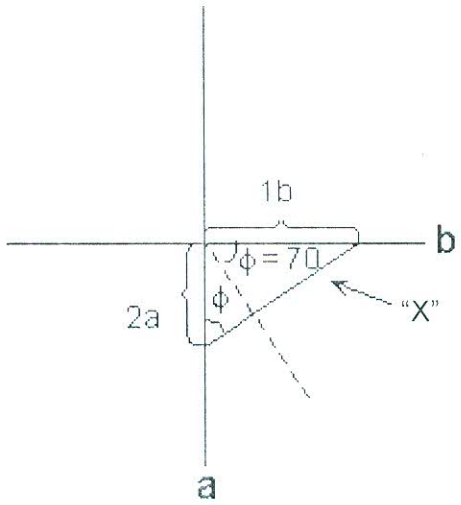
Kirakan formula empirik bagi mineral kuprum yang mempunyai peratus berat komposisi seperti berikut.

Cu^{+2} = 63.3% S^{-2} = 25.5%, Fe^{+3} = 11.2%

(40 marks/*markah*)

[b] Determine what would be the Miller Index assigned to this crystallographic planes and the respective axial ratio between *a* and *b*.

Tentukan apakah Indeks Miller bagi satah kristalografi yang ditunjukkan dan nilai nisbah paksi antara a dan b.



(30 marks/*markah*)

[c] Describe briefly the main principle of X-ray Fluorescence spectrometer (XRF). Sketch a basic component of an X-ray Fluorescence spectrometer. Also discuss briefly the effect of sample matrix in XRF determination.

Huraikan secara ringkas prinsip utama Pembelauan Sinar-X spektrometer. Lakarkan komponen asas alatan Pembelauan Sinar-X spektrometer dan juga bincangkan secara ringkas pengaruh matriks sampel dalam penentuan XRF itu.

(30 marks/*markah*)

PART B / *BAHAGIAN B*

3. [a] What is electro neutrality? Determine and write the electro neutrality components for mineral orthoclase ($KAlSi_3O_8$) and wollastonite ($CaSiO_3$).

Apakah itu keneutralan elektro? Tentu dan tuliskan komponen-komponen keneutralan elektro bagi mineral ortoklas ($KAlSi_3O_8$) dan wollastonit ($CaSiO_3$).

(30 marks/*markah*)

[b] Magnetic minerals result from properties that are specific to a number of elements. Describe the differences between diamagnetic, ferromagnetic and paramagnetic minerals giving appropriate examples.

Mineral-mineral magnetik berpunca daripada sifat-sifat yang khusus kepada beberapa unsur-unsur. Perihalkan perbezaan antara mineral-mineral diamagnetik, feromagnetik dan paramagnetik dengan memberikan contoh-contoh bersesuaian.

(40 marks/*markah*)

[c] Define Miller Index in crystallography. Given the following parameters, calculate the Miller Indices.

Takrifkan Indeks Miller dalam kristalografi. Untuk parameter-parameter berikut, kirakan Indeks Miller.

(i) a: 2a: b: 3c

(ii) a: infinity b: infinity: c

(iii) a: a: 3c

(iv) 2a: b: 5c

(30 marks/*markah*)

4. [a] Define the following physical properties of minerals:

(i) Cleavage

(ii) Luster

(iii) Hardness

(iv) Vectorial properties

Takrifkan sifat-sifat fizikal bagi mineral berikut:

(i) Ira

(ii) Kilauan

(iii) Kekerasan

(iv) Sifat vektor

(30 marks/*markah*)

[b] The garnet end-member pyrope $Mg_3Al_2Si_3O_{12}$ is cubic, has a density of 3.58 g/cm^3, and Z = 8, calculate the cubic cell edge.

Garnet unsur kumpulan akhir pirop, $Mg_3Al_2Si_3O_{12}$ adalah berbentuk kiub dengan ketumpatan 3.58 g/cm^3 dan Z = 8, kirakan sisi kiub selnya.

(40 marks/*markah*)

[c] Given the following mineral formulas, determine the valence (charge and number) of the element labeled "X" in each formula below:

Bagi formula-formula kimia mineral-mineral berikut, tentukan valensi (cas dan nombor) bagi elemen yang dilabelkan "X" dalam setiap formula berikut:

(i) $Mg_3X_2Si_3O_{12}$ (iii) $Al_6XPO_4(OH)_8.2H_2O$

(ii) $X_3Al_2Si_6O_{18}$ (iv) $KAlX_3O_8$

Given / *Diberikan*: P = +5

(30 marks/*markah*)

5. [a] Generally, mineral can be formed by any 4 unique processes. State and briefly discuss each process.

Secara umumnya mineral boleh terbentuk dengan 4 proses-proses unik terpilih. Sila nyatakan dan secara ringkas terangkan proses-proses berkenaan.

(30 marks/*markah*)

[b] Explain the basis of division in the classification scheme of mineral for mineral classes, subclasses, groups and series.

Terangkan asas pembahagian dalam skema pengelasan mineral bagi kelas-kelas mineral, sub-kelas, kumpulan dan siri.

(30 marks/*markah*)

[c] The hausmanite (Mn_3O_4) has a tetragonal crystal system. When a monochromatic radiation having a wavelength of 0.709 A° is used, the angle of diffraction is 20.2° (first order diffraction).
Given: Hausmanite tetragonal cell edge; a = 5.76 Å, c = 9.44, Z = 4

Sistem hablur bagi hausmanit (Mn_3O_4) adalah tetragonal. Apabila radiasi monokromatik yang mempunyai panjang gelombang 0.709 A° digunakan, sudut belauan adalah 20.2° (belauan tertib pertama).
Diberikan: Sudut sel Hausmanit tetragonal; a = 5.76 Å, c = 9.44, Z = 4

(i) Compute the inter-planar spacing for these set plane (101) and (021).

Kirakan jarak antara satah bagi set satah (101) dan (021).

(20 marks/*markah*)

(ii) If the second order diffraction was used and monochromatic radiation having a wavelength 1.545 Å, compute the diffraction angle for the plane (101) and (021).

Sekiranya belauan tertib kedua digunakan dan radiasi monokromatik digunakan mempunyai panjang gelombang 1.545 Å, kirakan sudut belauan untuk satah (101) dan (021).

(20 marks/*markah*)

6. [a] Given the following mineral formulae, determine the valence of the element listed as "X" in each formula.

Diberikan formula-formula mineral seperti berikut, tentukan valensi setiap elemen yang diwakili oleh simbol "X".

(i) $NaXB_5O_6(OH)_6.5H_2O$

(ii) ZnX_2O_4

(iii) $Pb_5(XO_4)_3Cl$

(iv) $Zn4(X_2O_7)(OH)_2$.

(30 marks/*markah*)

[b] Crystals, and therefore minerals, have an ordered internal arrangement of atoms. This ordered arrangement shows symmetry. State the types of symmetry and the operation involved.

Hablur, termasuklah mineral, mempunyai susunan dalaman atom-atom yang teratur. Susunan teratur/rapi atom-atom ini mempamerkan kesemetrian. Nyatakan jenis-jenis kesemetrian tersebut beserta operasi yang terlibat.

(30 marks/*markah*)

[c] Given Miller indices below, ρ and ϕ angles for crystal faces, that in combination, intersect all crystallographic axes, calculate the axial ratios of the mineral.

Diberikan indeks Miller di bawah, sudut-sudut muka kristal ρ dan ϕ yang secara kombinasi memotong kesemua paksi-paksi kristalografik, kirakan nisbah paksi mineral berkenaan.

Faces / *Muka-muka*	ρ	ϕ
(110)	90°	45°
(011)	70°	0°

(40 marks/*markah*)

7. [a] Define mineralogy. What does the "Definite chemical composition" and "highly ordered atomic arrangement" means?

Takrifkan mineralogi. Apakah yang dimaksudkan dengan "Komposisisi kimia tertentu" dan "susunan atom yang teratur"?

(30 marks/*markah*)

[b] Calculate the weight % of each element oxide in the mineral with the following chemical formula:

Kirakan peratus berat (%) bagi setiap unsur oksida bagi mineral dengan formula kimia berikut:

$Co_3(AsO_4)_2.8H_2O$ As = +5

(30 marks/*markah*)

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[c] Determine the chemical formula of the mineral with the following composition:

Tentukan formula kimia bagi mineral dengan komposisi kimia berikut:

Element oxide *Unsur oksida*	Molecular weight *Berat molekul*	Weight % *% berat*
BeO	25	13.97
Al_2O_3	102	19.00
SiO_2	60	67.03

(40 marks/*markah*)

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